Thos Conant Esq

Town of Oshawa,

PROVINCE OF ONTARIO.

REPORT

—UPON—

PROPOSED SYSTEMS

——OF——

WATER WORKS

——AND——

SEWERAGE

——BY——

WILLIS CHIPMAN,

Civil and Sanitary Engineer.

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TORONTO:
November 15th, 1902.

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TOWN OF OSHAWA,

PROVINCE OF ONTARIO,

SUMMARY OF REPORTS UPON WATER WORKS AND SEWERAGE,

BY WILLIS CHIPMAN, C. E.

Toronto, Nov. 15th, 1902.

TO THE MAYOR AND COUNCIL OF THE TOWN OF OSHAWA.

Gentlemen,—My full report upon your Waterworks problem is so lengthy that I propose to give at the outset, and as a preface, my conclusions :—

The following sources of supply have been investigated :—

(a)—Thompson's Springs.
(b)—Harper's Springs.
(c)—Lake Ontario.
(d)—Oshawa Creek,
(e)—Springs within or near Town.
(f)—Artesian Wells.

I have concluded to recommend the Thompson Springs as your source of supply, the water to be conveyed to Trewin's Hill through a ten inch pipe. For future fire service, a pumping station will be necessary at or near Trewin's Hill, but for the present it may be omitted.

The estimated cost of the completed system will be $160,000, but by omitting works not immediately necessary, the cost will be $142,000. Notwithstanding the high first cost, the operating expenses will be low. Within five years after the completion of the works, the revenue should meet the interest and sinking fund charges, if a proper sum be allowed for fire protection and for municipal purposes.

I recommend for your adoption the separate system of Sewerage, the greater part of the storm water being diverted into Oshawa Creek, the sewage proper to be taken to the southeastward and discharged into a stream after passing through a Septic Tank. I also recommend that all the sewers in town be built as local improvements, the corporation paying for the outfall sewers, the disposal works and the storm sewers out of general funds.

About $25,000 should be raised as the Town's share of the cost of sewerage.

The total sum to be raised by general by-law, for Waterworks and Sewerage, should be $167,000, if the gravity system of waterworks be decided upon, or $143,000 if the Lake System be adopted.

The pumping station that will in the future be required on Trewin's Hill to give a fire supply, will cost about $12,000. The reservoir will certainly not be necessary for some years. It will cost about $6,000.

In comparing my estimates with those you have formerly received, you will notice that I have included all probable items of expenditure. It has been my aim to omit nothing. On some items of a problematical character I may be too low, or too high, but I have allowed what I considered sufficient amounts.

Respectfully submitted,
WILLIS CHIPMAN,
Civil and Sanitary Engineer.

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TOWN OF OSHAWA,

PROVINCE OF ONTARIO,

REPORT UPON A SYSTEM OF WATER WORKS,

BY WILLIS CHIPMAN, C. E.

Toronto, November 15th, 1902.

TO THE MAYOR AND COUNCIL OF THE TOWN OF OSHAWA, ONT.

Gentlemen,—Early in May of this year I was consulted by your Waterworks Committee, and received instructions to examine the different proposed sources of water supply, and to prepare a report.

All the plans, reports, estimates, &c., in the office of the Town Clerk, were placed at my disposal, and the members of the committee, the members of the Council, and the town officials have given me valuable information and assistance.

Upon my first visit I examined some springs in the immediate vicinity of the town, known as the Henry Springs, and Grierson Springs, and also inspected the Harbor and the Lake Front for a mile or so to the westward.

On my second visit, on August 1st and 2nd, I inspected the test wells sunk by the corporation in July.

On my third visit, on September 4th and 5th, I inspected the springs at Raglan, and the Thompson Springs, and again examined the lake shore west of the Harbor.

On October 27th and 28th the results of my investigations were laid before you in a verbal report.

LOCATION.

The Town is situated on Oshawa Creek, a small mill stream about three miles north of Lake Ontario, into which the Creek empties.

The main line of the Grand Trunk Railway passes a few yards south of the southerly boundary of the Town, an Electric Railway line connecting the G.T.R. station with all the principal parts of the Town to the north, and with the harbor front to the south east.

The distance from Oshawa to Toronto is 34 miles, and to Montreal 300 miles.

The business portion of the Town has an elevation of about 110 above Lake Ontario. The highest point in Town is about 175 feet above the lake.

The Town limits include twelve Township lots, viz., Lots 7, 8, 9, 10, 11, and 12 in the 1st and 2nd Concessions of the Township of East Whitby, County of Ontario. The total area comprises about 2,500 acres, but the built up portion of the Town is on Lots 10 and 11 in the 1st Concession, and on the south half of the same lots in the 2nd Concession.

POPULATION.

In designing a system of waterworks for a town, an allowance should be made for some future increase in the population. In the older towns, where the increase in population from decade to decade has been small, it would be an extravagance to construct works with a capacity sufficient for more than double the present population.

The present population of Oshawa is given by the Town Assessor as 4,500 In 1890 the population was 4,100 by the census.

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The number of important industries now well established in your town, and the growing demand for their products, would indicate that the population will increase materially in the immediate future.

By the Dominion Government census, the population of many of the towns in the older settled parts of the Province, are given as follows:—

	1870	1880	1890	1900
Arnprior	1,714	2,147	3,341	4,152
Barrie	3,398		5,550	5,949
Belleville	6,277	7,305	9,516	9,117
Bowmanville	3,034	3,504	3,377	2,731
Brockville	5,102	7,609	8,791	8,940
Cobourg	4,442	4,957	4,829	4,239
Cornwall	2,033	4,468	6,805	6,704
Hawkesbury	1,671	1,920	2,042	4,150
Ingersoll	4,022	4,318	4,191	4,573
Lindsay	4,049	5,080	6,081	7,003
Napanee	2,967	3,680	3,433	3,143
OSHAWA	3,185	3,992	4,066	4,394
Perth	2,375	2,467	3,136	3,588
Peterboro	4,611	6,812	9,717	11,239
Port Hope	5,114		5,042	4,188
Prescott	2,617	2,999	2,919	3,019
Smith's Falls	1,150	2,087	3,864	5,155
Strathroy	3,232	3,817	3,316	2,933
Trenton	1,796	3,042	4,363	4,217
Whitby	2,732	3,140	2,786	2,110
Woodstock	3,982	5,373	8,612	8,833

Allowing an increase of only 10 per cent. per decade, the population of Oshawa would be about 6,000 in thirty years.

In the schedule above, the majority of the places have increased slightly, a large number have gone backward, and a few have increased very rapidly.

Thirty years ago Peterboro and Woodstock were very little larger than Oshawa is to-day.

Hawkesbury, on the Ottawa River, has doubled its population in ten years.

Although it may be probable that your population will not exceed 6,000 in thirty years, it is possible that it may be 9,000, and in my opinion your waterworks system should be so designed that 6,000 people may be now supplied, and that without abandoning or rebuilding any important part of the system, the supply may be ample for 9,000 population.

QUANTITY.

Throughout the Province of Ontario, the quantity of water consumed daily per capita in waterworks cities and town, varies from 20 gallons to 200 gallons. The average probably lies between 80 and 100 gallons for each consumer. In places that take their supply from the great lakes or the rivers connecting them, the consumption is the greatest owing to the unlimited supply of water and the less cost of fuel. The cheapness of the supply favors waste and extravagance. In other places the consumption is much less.

For domestic purposes the amount required should not exceed 40 gallons per capita. After allowing 10 gallons per capita for leakage, and the same amount for municipal purposes, the total is only 60 gallons. All over and above this is waste, that can only be reduced by the general adoption of meters.

Assuming a population of 9,000 people all using water, and 70 gallons per capita, the total consumption would average 360,000 gallons per day.

During a dry season the daily consumption will exceed this average and might be as much as double the average. In every town, however, some of the citizens will not take city water, and when your town attains a population of 9,000, it is not probable that more than 8,000 people would be supplied from the town water mains, in which case the maximum dry weather consumption should not exceed 1,000,000 gallons per day, or 700 gallons per minute for the driest summer days.

This consumption will not, in my opinion, be exceeded by the Town of Oshawa for one generation at least, and for some years about half of this quantity will be ample, or say, 350 imperial gallons, or 420 U. S. gallons per minute.

The question to decide is, whether a system of waterworks should be constructed that may be found quite inadequate within ten years, or to expend less than ten per cent. more and build works that will supply a population of 9,000.

METERS.

By the general adoption of meters the domestic consumption would be reduced from 70 gallons to 40 gallons per capita. If meters were placed in every service, as each was laid, the average cost would not exceed $15 for each meter.

Sooner or later all consumers will be supplied by meter, but at the present time the citizens of Canadian cities and towns prefer to spend large amounts on machinery and mains rather than smaller amounts on meters.

If you adopt meters from the first you will postpone for many years he necessity of erecting a pumping station on Trewin's Hill.

FIRE SUPPLY.

In addition to the foregoing domestic supply, sufficient water must be provided for a fire service. The quantity required for this purpose during the year will be relatively small, probably not exceeding one million gallons, or less than 3,000 gallons per day, or about two gallons per minute. This amount of water would supply five fire streams for about eighteen consecutive hours. The full fire supply must, however, be available at all times and under a sufficient pressure or head. The hydrant pressure, when the fire streams are running, should not be less than 80 pounds, and 90 is better.

The Fire Underwriters' require five streams at one time for Class A, four for Class B, and three for class C.

In my opinion your fire supply should be sufficient to give four fire streams under a pressure of 90 pounds at the hydrant in the vicinity of the corner of King and Simcoe Streets when delivering 200 gallons each through 300 feet of hose.

Adding the domestic supply to the fire supply gives a total of 1,300 gallons as a future maximum, and 1,000 for the immediate future.

QUALITY.

Water for dietic purposes should be colorless, tasteless and odorless, free from all injurious matter, whether in suspension or in solution. For laundries, for baths, for kitchen use and for boilers, it should not be too hard.

The water should also be free from any suspicion of sewage contamination, and from direct drainage from tilled fields, barnyards, stables, etc.

HISTORICAL.

It may be of interest, as a matter of record, to summarize here the different reports that have been presented, from time to time, by the several Engineers whom you have employed.

The first report and estimate was prepared by Mr. John Galt in the year 1898. He proposed a gravity supply from Raglan's Springs, the water to be conveyed through about nine miles of pipe to an elevated storage tank on Trewin's Hill, the highest point in Town. His conduit comprised 3,000 feet of 12 inch, 7,000 feet of 10 inch, 16,000 feet of 8 inch, and 20,000 feet of 6 inch, the latter being at the Town end.

His proposed storage tank was to be 25 feet in diameter, 30 feet in height, resting on a brick tower 85 feet in height. The distribution system included over ten miles of piping.

The estimated cost of the complete system, as given in the By-law submitted in January, 1899, was $80,000.

Tenders were called for the construction of the works on June 4th, 1899, a short time before the By-law was voted upon, the lowest tenders being somewhat less than the Engineer's estimate of cost, but the cost of engineering, superintendence, land, riparian rights, etc., would probably have brought the cost considerably above the $80,000.

This first By-law was carried on January 21st.

Immediately afterward Mr. E. H. Keating was engaged to report. He recommended that the conduit should not be less than eight inches in diameter, that a larger reservoir be constructed in town, and suggested investigating other sources of supply. This report is dated Feb. 28, 1899. The plans were revised and new tenders called for on May 5th, 1899. A ground reservoir to contain 600,000 gallons and a pumping station, both to be located or Trewin's Hill, were added to the original scheme, and the elevated tank reduced in capacity to 60,000 gallons. The conduit and distribution system remained practically as before. The prices received exceeded the amount provided by By-law.

In 1899, by a special Act of the Provincial Legislature, By-law No. 460 carried, in January, 1899, was confirmed, permitting the debentures to extend over forty years instead of thirty years as provided by statute. (63 Vic., Chap. 65.)

In September, 1899, Mr. M. J. Butler reported upon the cost of a pumping system with Lake Ontario as the source of supply, the estimated structural cost being $76,434. This report was not made for the Council, but at the request of a private citizen, but was, however, published in the local newspapers. Mr. Butler reported against another scheme, taking water from Oshawa Creek above the Town, and pumping part of the year by water power.

In 1900 nothing appears to have been done except to secure some further legislation. In this year the Corporation was empowered by the Legislature (63 Vic., Chap. 79, Sec. 3,) to issue the debentures authorized by the first By-law at any time during twenty years, and was also empowered (Sec. 4) to submit a By-law at any time within twenty years for any necessary amount for Waterworks and Sewerage, the debentures to extend over a period of forty years, such By-law to receive the assent of the ratepayers.

In January, 1901, the problem was taken up again by the Council.

On February 23rd, 1901, Mr. R. E. Speakman, (formerly Mr. Galt's partner) presented an estimate for a gravity supply from Raglan Springs through an eight inch conduit, and a 450,000 gallon reservoir in Town, the cost being placed at $103,738, exclusive of engineering, superintendence, riparian claims, etc.

Mr. W. T. Jennings was shortly afterwards engaged to report fully upon the different proposed schemes.

He recommended an eight inch conduit from Raglan Springs to a ground storage reservoir to contain one and one-half million gallons, to be located about four miles from Oshawa with a twelve inch conduit from the reservoir to Town, and an elevated reservoir on Trewin's Hill, or a fourteen inch pipe instead of the twelve inch, in which case the second reservoir might be omitted. The estimated cost of this system he placed at $150,205.

Mr. Jennings gave an estimate upon the cost of a Lake pumping system as $100,323; also upon a pumping system from Oshawa Creek, from a point north of the 4th Concession, but the latter was not recommended. Mr. Jenning's report is dated March 28th, 1901.

In the latter part of May, 1901, tenders were again received for the construction of works, the plans and specifications having been revised partially to accord with Mr. Jennings recommendations, the conduit being 8 inches in diameter from the springs to the reservoir, and 12 inches from the reservoir to Town. No reservoir or storage tank or pumping station on Trewin's Hill was included.

For a gravity supply the lowest tender was $104,672, and for a lake system $94,581.

On June 4th, 1901, a few days after the tenders were received, the ratepayers defeated a By-law to raise $40,000 in addition to the amount raised by the first By-law for Waterworks and Sewers. About $30,000 was probably for Waterworks, making the total estimated cost $110,000.

In February, 1902, Mr. Speakman presented another scheme to the Council, the supply to be taken from Thompson's Springs, at the headwaters of a branch of Oshawa Creek, rising about two miles east of the Raglan Springs. The water was to be conveyed through an eight inch conduit from the springs to a storage reservoir on McGregor's Hill, about three miles north east of Trewin's Hill, thence by a twelve inch main to town. The estimated cost of this proposed system was approximately $125,000, ($150,000 for Waterworks and Sewers.)

A By-law was drawn up and duly advertised, and the vote was to have been taken on March 29th, but before the day of voting the By-law was withdrawn.

SOURCE OF SUPPLY.

With the broad expanse of Lake Ontario lying within view of the town to the south, and the elevated ridges from which the numerous springs that unite to form Oshawa Creek, within sight to the north, the problem of securing an ample supply of pure water would appear to be an elementary problem of engineering. But it is not as simple as it appears.

The town has an elevation varying from 75 feet to 177 feet above Lake Ontario three miles away, the average being about 120 feet; while the springs along the southerly slope of the ridges, and distant nine or ten miles, have elevations from 500 to 600 feet above the lake.

Owing to the cost of conveying water from the hills, and of pumping lake water three miles to a proper elevation above the town, several additional sources of supply have been investigated, the total number being as follows:—

(a) Thompson's Springs and vicinity on Lots 6 and 7 in the 8th Concession of the Township of East Whitby.

(b) Harper's Springs, near Raglan, on Lot 13 in the 9th Concession.

(c) Lake Ontario.

(d) Oshawa Creek.

(e) Springs within or near town.

(f) Artesian wells.

THOMPSON'S SPRINGS.

In the summer season small springs appear on the south side of the road in front of the 9th concession, on lot 6, which produce a rivulet that gradually increases in volume as it flows southerly, until its dry weather flow on the south half of lot 7 is stated to be over one million of gallons per day.

A well defined water course can be traced for some distance northerly from the 9th concession line, indicating a stream of considerable size during rains and when snow is melting. In the 8th concession the brook has a rapid fall and the valley in which it flows is bounded by hilly ground from 40 to 70 feet higher. Although the valley of the stream is for the most part in swamp or in scrub timber, through which cattle pasture, the high ground adjoining is cultivated, and from driftwood seen it is evident that surface water at times swells this spring brook to many times its dry weather flow.

Mr. George H. Pedlar, of Oshawa, has during the past few years leased parts of Lots 7 and 8 in the 8th Concession, containing about five acres, and has expended a considerable sum in the construction of trout ponds and improvements.

A short distance north of the 8th Concession Road this stream is joined by another of about the same size from the eastward. The drainage area of the latter is, however, much larger than that of the former.

A mill dam existed at one time immediately below the confluence of the two brooks, but it has long since been abandoned.

The water from the Thompson Springs is suitable for a public water supply, and I am certain that a sufficient quantity can be secured for all Town purposes without contamination from surface drainings by the construction of subterranean collecting galleries or reservoirs. Some ditching and other work of a comparatively inexpensive character will be necessary to divert the surface water from the source of the Town supply.

After proper detailed surveys have been made, I feel confident that a point can be selected along the valley of the stream in the 8th Concession from which a supply of water can be obtained for the use of the Town without directly taking water from the springs or from the stream.

HARPER'S SPRINGS.

These springs rise in Lots 12 and 13 in the 9th Concession, and about half a mile north of the Village of Raglan. The largest springs are within a smaller area than the Thompson Springs, and within a mile the flow is sufficient to run a small gristing mill now in operation. The surface drainage area is also less than that of the Thompson Springs, and more hilly.

The quantity of water flowing at the private road between the springs and the mill has been found to be over one million gallons per day by weir measurement in the dry season.

The quality of the water is the same as that from the Thompson Springs. On this stream there are three mills between the springs and the junction with the stream from Harper's Springs in the 4th Concession, but on the Thompson Stream there is only one mill—that of Mr. James Goodman, in the 6th Concession.

LAKE ONTARIO.

The water of the great Lakes, when taken at a sufficient distance from shore to secure clear water during gales, is an excellent water for a public water supply.

Nearly all of the large cities situated on the great Lakes and the Rivers connecting them, and many of the towns in Canada and the United States draw their supply from them, and in the majority of cases the sewage is also discharged into them, with the result that the water supply, although pure at first, becomes in time contaminated more or less with the sewage. Extending the intakes, or filtering the water, or purifying the sewage, are resorted to, but as the population increases, so does the danger of polution, necssitating further outlays for protective measures.

When there is an accumulation of sand or gravel along the lake shore, filter basins have in some places proven satisfactory, but in several places they have been abandoned because of their failure to supply a sufficient quantity of water, or have been destroyed by storms.

Directly south of Oshawa, on lots 9 and 10, in a slight indentation in the shore, there is a low gravel beach with a marsh back of it, that would be suitable for a pumping station. Soundings opposite this beach show a depth of 14 feet at 900 feet distant from shore line, 17 feet at 1,000 feet, 20 feet at 1,200 feet, and 24 feet at 1,500 feet.

The turbidity caused by winds could be removed by constructing a sedimentation basin, or by mechanical filters. It is possible that filtration basins similar to those at Port Hope might prove satisfactory, but tests on a large scale would be necessary to determine this.

Oshawa Creek enters the lake about a mile to the east, but I am of the opinion that until your population has increased several fold, that there would be little chance of this creek water reaching the Waterworks intake. A prominent headland projects into the lake on Lot 8, forming a protecting pier from easterly winds and currents. Moreover, the sedimentation basin, or the filters, would remove any contamination that might possibly arise. There would, however, always be a suspicion that the water might become affected by sewage, and no doubt the proper purification of your sewage would be considered as imperative from the time the Waterworks system was completed.

OSHAWA CREEK.

Oshawa Creek within the town limits is unfit for domestic use. The greater part of the area of the watershed is arable farm land, with a good fall, the result being that the stream is subject to great variations in volume, and during rains and freshets carries large quantities of suspended matter.

By sedimentation and filtration it might be made a safe water, but the purifying process would mean an additional annual expenditure, and by the carelessness of a workman at any time, impure water might be turned into the mains.

It has been suggested that a dam be constructed on the stream at some point above the town, below the confluence of the two main branches in the 4th Concession and develop power for pumping. The head to be pumped against would be considerably less than if the pumping plant were at the lake shore.

I concur in the report of the other Engineers that this system would be unsatisfactory. The volume of flow would not be sufficient for power, except for a portion of the year, thus involving the installation of a steam pumping plant in addition to the cost of the dam,

flumes, water wheels, power pumps, etc. The amount of water to be obtained from the stream would not justify the expense of developing it.

VARIOUS SPRINGS.

In May I examined some springs on Lots 9 and 10 in the 3rd Concession, about two miles north-east of Oshawa, also springs in the valley of Oshawa Creek in Lots 11 and 12 in the same concession, the latter being known as the Henry Springs.

In my opinion a sufficient quantity of water for the Town's requirements could not be obtained from any of these springs, and their elevation is not sufficient to give a gravity supply.

I also inspected springs on Lots 14 and 15, in the 2nd Concession, immediately west of the Town. The visible supply from these springs was not sufficient in amount, and the flow could not, in my opinion, be materially increased.

Within the Town limits north of Louisa street and west of the Park, exists a spring that has been developed for many years to supply water by gravity to the Piano factory on Bond street. During the summer three test pits were excavated in the vicinity of this spring to ascertain the prospect of obtaining a Town's supply.

The first test well was sunk about 35 feet from the old spring. It was about 3 feet in diameter and 13 feet deep. A second well was sunk about 200 feet to the north-west, and a third about 180 feet to the north, these last two wells being 75 feet apart.

Each was about four and one-half feet in diameter and 14 feet in depth.

The wells filled with water but the overflow was trifling.

A steam pulsometer pump was used for testing the wells.

No. 3 well was pumped out in an hour and filled during the night, rising the first four feet in six minutes, but it did not overflow until the following day. Pumping from well No. 3 lowered well No. 1 about six inches, and well No. 1 about 18 inches.

Pumping from No. 1 did not appear to affect the other wells.

No. 3 well recovered at the rate of 80,000 gallons per day, and well No. 1 at the rate of 17,000 gallons per day.

The small area of the watershed sloping towards the point where the wells were located indicated that only a limited supply of water could be obtained from these wells, and the tests confirmed the surface indication.

I am certain that a sufficient quantity of water cannot be obtained from wells or subterranean galleries at this point or any other point in the vicinity, although the quality of the water might be excellent.

ARTESIAN WELLS.

In the south west portion of the Town I am informed that good water can always be found in a gravel bed overlying the rock which is struck from 15 feet to 30 feet below the surface.

In the north-east part of the Town good wells are rare, probably owing to the fact that they are not sunk to a sufficient depth to strike the water bearing gravel bed above mentioned.

Many attempts have been made to obtain water by deep wells, but with little success.

Mineral water was struck in a well at Charles street and Bruce street, at a depth of about 60 feet. On Athol street, west of Simcoe, a well was sunk 25 feet to rock, and at 70 feet in the rock a supply of

water was struck. This well was drilled 60 feet further, ending in Trenton limestone, but there was no increase in the water supply.

In 1901 the Town Council of Whitby sunk five test wells, varying in depth from 90 feet to 216 feet. None of these wells overflowed and it was decided that a supply of water could not be obtained for Town purposes in this way.

I know of no place in Ontario where artesian wells have been discovered by drilling into or through the Hudson River, Utica or Trenton Rock formations.

In my opinion there is no possibility of obtaining water from artesian wells in the vicinity of Oshawa.

SOURCES COMPARED.

Of the different proposed sources, only three can be favorably considered :—Thompson's Springs, Harper's Springs, and Lake Ontario.

As to chemical purity under normal conditions, there is little or no choice. The water from the springs is harder than the lake water, but less liable to contamination in the future; a better water for dietetic purposes, but not so good for laundries and steam boilers.

The spring water will flow by gravity to Town, the pressure being sufficient for fire purposes while the lake water would require pumping.

The lake supply would be limited only by the capacity of the pumping machinery, while the supply from the springs would not be sufficient for a very large city, although there is sufficient flow from either of the two largest springs for three times your present population.

The first cost of the gravity system will be more than the lake system, but the annual expenditure for pumping would, in my opinion, in a few years exceed the interest and sinking fund charges on the additional cost.

Taking into consideration the first cost, the operating expenses, the maintenance charges, the efficiency of the service, the prospective future growth of the Town, the sewage disposal problem, and the claims of riparian owners, I have concluded to recommend for your adoption, a gravity supply from the Thompson Springs.

If, however, the first cost of the proposed gravity system be considered too great, or beyond the borrowing capacity of the Town, then the lake system may be adopted.

ANALYSES.

The following chemical analyses were made in October 27th, 1898, by J. J. McKenzie, then analyist on the staff of the Provincial Board of Health :—

In parts per million.	Harper's Springs.	Thompson's Springs.
Free Ammonia	none	trace
Albu. Ammonia	trace	trace
Chlorine	1.680	1.680
Oxygen consumed	1.748	1.600

In 1899 the acting master mechanic of the Grand Trunk Railway, T. McHattie, collected water from the Harper Springs, which

was sent by F. W. Morse to G. P. Girdwood, of Montreal, for analysis, with the following results :—

	Per gallon.	Parts per million.
Total solids	15	214
Total hardness	12	171
Temporary hardness	5.4	77
Carbonate of lime held up as bicarbonate.	5.4	77
Sulphate of lime and magnesia	7.0	100
Chloride	trace	trace
Organic matter	trace	trace
Alkaline salts	3	43
Totals	15.4	220

"The water is a good water for boilers, having but little scale material and no injurious acids."

The quantities in the last column I have added that the results may be more readily compared with the others.

It is to be regretted that the analyses of the Provincial Board do not give the hardness, and that no reference is made to the quality of the water for steam boilers.

The results of several analyses made by W. H. Ellis, of Toronto, during 1887-1891 of Lake Ontario water, from different points, and of London city water derived from springs, in parts per million, are as follows :—

	Lake Ontario.	City of London, Ont.
Free Ammonia	trace to 0.08	trace
Alb. Ammonia	trace to 0.12	trace
Chlorine	4 to 5.0	1.50
Oxygen consumed 15 min.	0.19 to 0.73	trace
" " 4 hrs.	0.40 to 1.09	trace
Total solids	126 to 156	275

The water from the Thompson Springs and Harper Springs is considerably harder than Lake Ontario water, but softer than the city water at London. Prof. Girdwood's report is, however, favorable to the spring water for locomotive boiler use.

GRAVITY SUPPLY.

The Harper Springs, near Raglan, have an elevation of about 360 feet above Trewin's Hill, and 450 feet above the intersection of King Street and Simcoe Street.

The distance from Harper Springs to King Street is approximately 10 miles.

The Thompson Springs are about 30 feet lower than the Harper Springs, but they are about half a mile nearer Town.

Assuming a conduit of the same size laid from the two springs, the flow from the Harper Springs would exceed that from the Thompson Spring's by only one per cent.

If the conduit pipe were closed at the Town end, the pressure from the Harper Springs would be 195 pounds, and from the Thompson Springs 182 pounds to the square inch at King and Simcoe Streets. As this pressure is double what is necessary, it must be reduced either by simply wasting the water not required through relief valves, or by stand pipes erected on the conduit at suitable points.

Before deciding upon the size of the conduit to be laid, something should be said respecting reservoirs.

RESERVOIRS.

Under this heading I will include elevated storage tank and stand pipes. Immediately south of the springs a relatively small covered reservoir should be constructed, into which the different pipes laid for collecting the spring water should discharge. It should be provided with necessary stop gates, overflow, by-pass pipes, screens, etc., and it should be located at some accessible point. This reservoir may be called the collecting reservoir.

If a small sized conduit be laid to Town a large storage reservoir will be necessary for a reserve fire supply. Unfortunately there is no hill in town of sufficient elevation to give a fire pressure, and it would be necessary to construct an elevated tank or standpipe on Trewin's Hill about 160 feet in height for this purpose; or to construct a ground resevoir at the surface of Trewin's Hill and pump from it into the distribution system during fires.

If a standpipe or elevated tank were erected, it should have a diameter of at least 30 feet. Three fire streams running continuously for five hours would lower the water in this standpipe about 40 feet, thus decreasing the head.

A standpipe of this size would be an expensive structure, and larger than anything of the kind in Canada.

A ground level reservoir with a pumping station adjoining would would cost less money and would, in my opinion, be preferable.

Between Oshawa and Harper's Spring, there is no hill for a reservoir site superior to Trewin's Hill. Proceeding northward there are hills that are higher, but the friction loss would require a large main to be laid from the reservoir to Town.

In the rear part of Lot 12, in the 7th Concession, the ground rises to an elevation of 180 feet above Trewin's Hill, the distance between them being over four miles. This elevation is the same as that of McGregor's Hill about three miles north-east of Trewin's Hill, and three miles distant. The McGregor Hill is therefore to be preferred as a reservoir site.

It is obvious that the nearer the storage reservoir be to the Town, the better for domestic supply as well as for fire service. If a reservoir be placed on McGregor's Hill, a large main must be laid to Trewin's Hill, and if this main should be accidentally broken, the Town would be without a water supply.

If the storage reservoir be constructed on Trewin's Hill, there would be less chance of the Town's supply being cut off, but for fire supply a pumping station would be necessary.

The cost of the pumping station would be less than the extra cost of the large main necessary for fire supply over the smaller main for domestic service only, from McGregor's to Trewin's Hill; but, on the other hand, the cost of heating the pumping station and operating it during fires would add to the operating expenses.

The storage reservoir, whether on McGregor's Hill or on Trewin's Hill, should have a capacity of not less than half a million gallons, and one with double this capacity would be better, particularly so if built as an open surface reservoir, as the smaller the open reservoir the greater the liability of pollution from vegetable growths in the summer months.

If the conduit were 10 inches in diameter from Thompson's Springs to Trewin's Hill, a stand pipe of sufficient height for domestic pressure and of proper capacity for fire purposes, might be substituted for a ground reservoir, but the cost would be greater.

If the lake system be adopted, a stand pipe 30 feet in diameter and about 60 feet in height should be erected on Trewin's Hill for domestic service. This tank would contain about 180,000 gallons, sufficient for the night supply, thus permitting the pumping plant to be shut down at night. During fires the stand pipe would be cut off and direct pressure given by the pumps.

SIZE OF CONDUIT.

The proper size of the conduit to be laid for a gravity supply depends upon the prospective population, a matter of conjecture. It is not surprising, therefore, to find Engineers differing widely in their conclusions respecting this matter.

It must not be forgotten that the discharging capacity of an iron pipe may be materially decreased in a short time by sedimentation, by the growth of "tubercles," and by corrosion. The smaller the pipe the greater the percentage of loss. There is no means of determining in advance to what extent a pipe line will be affected, but it is certain that it will, in some degree, lose its theoretical carrying capacity.

Conduits can be scraped and cleaned, but this involves expense. Soft waters affect pipe to a much greater extent than hard waters.

An 8 inch main laid from the Thompson Springs to Trewin's Hill will, when new, deliver about 500 gallons per minute running free, sufficient for a population of 6,500 people.

To give an efficient fire service in town, an elevated tank or standpipe would be necessary 160 feet in height above Trewin's Hill. The flow into it would be decreased to 370 gallons per minute when filled to the top, only sufficient for the present population.

It is evident, therefore, that an 8 inch main, when new, is entirely too small except for the domestic supply, delivered at a low elevation.

A 10 inch main would be too small to give a fire service, but would supply 700 gallons per minute at a good domestic pressure, sufficient for a population of 9,000 people.

A 12 inch main would now give five efficient fire streams in addition to the domestic supply, but in about 15 years or so, it is doubtful if more than three streams would be available for fires. It would then be necesary to add a pumping station in Town.

Notwithstanding the exceedingly slow growth of the Town during the last 20 years, I cannot assume the responsibility of recommending you to lay an 8 inch conduit pipe.

With a 10 inch conduit, a reservoir and pumping station would be neceessary for fire service. The pressure from the conduit alone would be ample to cope with an incipient fire.

I have given considerable time to the proposition of constructing a large storage reservoir on McGregor's Hill, the water to be conveyed to it by a conduit of sufficient size for the maximum domestic supply, and to lay a large main to Town from the reservoir for a fire supply.

An 8 inch conduit laid from the Thompson Springs to McGregor's Hill will deliver 405 gallons per minute, sufficient for a population of about 3,000 people. This is the theoretical discharge, and cannot be relied upon for the future, but this size might be sufficient for a few years, probably 10.

If the population of the Town should so increase that the 8 inch conduit failed to deliver a sufficient amount of water, another 8 inch conduit might be laid to the Thompson Springs or to the easterly branch of the Thompson brook, or to the Harper Springs.

A 12 inch main from the reservoir on McGregor's Hill will deliver 800 gallons per minute at Simcoe and King Streets, at 90 pounds pressure, and a 14 inch will deliver 1,200 gallons at the same pressure. A 14 inch main is none too large.

For fire service, a pumping station would eventually be necessary at Trewin's Hill or vicinity, when the domestic supply increased, but in my opinion it would not be required for many years, with a 14 inch main.

In this scheme the possibility of the Town's supply being completely cut off by an accident to the 14 inch main cannot be overlooked.

The cost of a reservoir on Trewin's Hill will be no more than one on McGregor's Hill, and the extra cost of the three miles of larger main required will more than equal the cost of the pumping station. There is some advantage, also, in having the reservoir and pumping station within the Town limits.

Taking everything into consideration, I am of opinion that the reservoir and pumping station on Trewin's Hill. will give a better fire supply than if the reservoir be placed on McGregor's Hill.

RIPARIAN CLAIMS.

The only claims for damages that can be successfully made against the town for diversion of water from the springs for Waterworks purposes, are those of the existing mill owners, and in my opinion the amount of each claim would be determined by ascertaining the decrease selling value of each property after the water has been diverted.

Prospective values of undeveloped water powers, can have no value on streams, along which there are so many abandoned dams and power privileges. The farmers have no claims unless deprived of sufficient water for their farming operations.

Between the Thompson Springs and the Lake there are now four developed powers, as follows :—

(1) Goodman's grinding mill, on Lot 8, in the 7th Concession—head 22 feet.

(2) McLaren's grist mill on the north side of King Street, in Oshawa—head 25 feet.

(3) The electric light plant and grinding mill half a mile below King Street—18 feet head,

(4) The Cedar Dale tannery between Oshawa and Lake Ontario—head feet.

At Orangeville, Ontario, the flowing stream was apparently unaffected by the diversion of water for the Town's use from the valley in which the springs rose that fed the stream. The undetermined damages that would be claimed by mill owners along the stream and the costs of litigation were urged by those who opposed the Waterworks By-law in 1895.

Claims were filed by one mill owner, at least, before the Waterworks system was completed, but no further action was taken. At Orangeville we were careful to take no water from the stream directly or from any springs, but we obtained sufficient water nevertheless on property adjacent. owned by the Corporation.

The United States laws respecting underground waters differ widely from our Canadian laws, and their practice and decisions do not apply here.

On the Harper's Springs stream there are six mills as follows :—
(1) Ross' grinding mill, on Lot 14, in the 9th Concession, at Raglan,

a short distance below the Springs—head 16 feet.
(2) Pringle's mill, immediately below the foregoing, Lot 14, in the 8th Concession—head feet.
(3) Plowright grinding mill, on Lot 15, in the 7th Concession—head 22 feet.
(4) The McLaren mill, in Oshawa.
(5) The Electric Light Station, in Oshawa.
(6) The Cedar Dale Tannery.

The larger mills have an auxiliary steam plant, and none can run 24 hours per day by water in the summer season.

The diversion of water for town purposes from the Harper Springs or the Thompson Springs would probably not be noticed by the mill-owners on the stream below the 4th Concession, as the dams, mill races and flumes are of such a character that more water is now wasted than the town will require.

The riparian claims on the Thompson Springs branch will evidently be less than those on the Raglan branch, as the Goodman mill is the only developed power on it.

By adopting the Thompson Springs as a source of supply in preference to the Raglan Springs, I estimate that the riparian claims will be about one-third less.

LAKE SYSTEM.

To pump water from Lake Ontario through a 12 inch force main to a reservoir on Trewin's Hill, of sufficient height to give a fire service in Town, would give a pressure of about 150 pounds to the square inch at the pump house.

With a stand pipe 60 feet in height the pressure at the pump house would average 110 pounds when pumping.

During fires the pressnre would be over 150 pounds at the pump house.

These pressures are higher than the average in Ontario cities and towns, and would involve installing heavy pumping machinery.

To erect a standpipe 110 high. would be, in my opinion, a mistake. It would be better to make it from 60 to 80 feet in height, and arrange to pump direct for fires.

The cost of fuel would be about $20.00 per million gallons, if ordinay compound duplex pumping engines were adopted, such as they have at Port Hope, Cobourg, Belleville, and in many other places.

By adopting machinery costing double the money of the duplex pumps, the fuel account can be cut in half. High duty engines may be seen at Petrolea, Galt, Brockville, Toronto Junction, and in all the larger cities.

One high duty pumping engine and one duplex steam fire pump should be installed, each with a capacity of about 700 gallons per minute ; also two one hundred horse power boilers. Although many towns have but one pump for several years, the pressure is so high in your case, that two pumps should be erected at first.

The cost of carting coal from the harbor to the proposed pump house site would become an important item in a few years. It might be found cheaper to build a wharf and coal shed than to pay cartage and wharfage.

An intake pipe 12 inches in diameter would be quite sufficient in size, and I can see no reason for a greater length than 1,100 feet from shore, at which point the depth is about 17 feet. At Petrolea a similar intake was successfully laid in 1897 under my supervision,

on the fully exposed shore of Lake Huron. You might expect slightly turbid water at times, and occasionally "frasil" ice might temporarily obstruct the intake. These troubles are common to all lake pumping stations.

A filter should be installed at once, although it is not probable that it would be necessary to operate it many days in the year. The cost of filtration would be trifling, probably not more than one dollar per million gallons for the water filtered.

A sedimentation basin may be constructed later, if the filter should become overworked, or another filter may be added.

For several years (5 to 10) one employee could act as engineer and fireman at pump house. It would be necessary to build a cottage for the Engineer adjoining the pump house, and a plot of land secured.

It would also be necessary to connect the pumping station by telephone with the town, and to place fire alarm gongs in the cottage and pump house.

The firemen in town could cut off the stand pipe when they considered it desirable to do so.

The lake system would prove satisfactory in every way, the strongest objection against it being the possibility of sewage pollution. This objection might be more sentimental than real, but it would doubtless have some effect upon your Waterworks revenue, and would force the town to expend a larger amount upon sewage disposal works than it would otherwise do.

The wear and tear on pumping plant; or the depreciation would be more than on a gravity system.

DISTRIBUTION SYSTEM.

The plan of distribution prepared by Messrs. Galt & Speakman, is in my opinion, more extensive than the fire protection of the Town demands, and for domestic service only, a less expensive system may be adopted.

Mains should be so laid as to give an efficient fire service, and on such other streets as the revenue will warrant.

After going over the town carefully, I am of opinion that the following lengths of mains need not be exceeded :—

1,800 feet of 12 inch.

8,200 feet of 10 inch.

5,200 feet of 8 inch.

18,500 feet of 6 inch.

11,000 feet of 4 inch: making a total of 44,700 lineal feet, or over eight miles, an amount above the average for a town of your size.

I have included 100 standard fire hydrants in my estimate and the necessary valves, etc.

ESTIMATES OF COST.

The following estimates of cost are based upon current prices of materials and labor, and are at least 25 per cent. higher than the prices of three years ago.

SCHEME (a).

Gravity supply from Thompson Springs direct to Trewin's Hill by 10 inch conduit, capacity 700 gallons per minute for domestic pressure, direct pumping for fire pressure.

(1) Developing springs and Collecting Reservoir	$ 5,000
(2) Land and right of way	3 000
(3) Riparian Claims	10,000
(4) Conduit 10 inch, 43,000 feet long	65,000
(5) Reservoir Trewin's Hill	6,000
(6) Pumping Station Trewin's Hill	12,000
(7) Distribution system	50,000
(8) Services	3,000
(9) Engineering and Legal	6,000
	$160,000

Omitting the pumping station, and the reservoir on Trewin's Hill, this estimate will be reduced to $142,000.

SCHEME (b)

By substituting an 8 inch pipe for the 10 inch, the cost would be reduced to $147,000, but the capacity would only be 400 gallons per minute.

SCHEME (c).

Gravity supply from Thompson's Springs to reservoir on McGregor's Hill by a 10 inch main, thence a 14 inch main to Trewin's Hill.

The capacity of a 10 inch conduit would be 750 gallons per minute, and of the 14 inch about 1,200 gallons per minute, under fire pressure.

At some time in the future a pumping station would be required in town.

(1) Developing springs and collecting reservoirs	$ 5,000
(2) Land and right of way	3,000
(3) Riparian claims	10,000
(4) Conduit 10 inch, 30,000 feet	45,000
(5) Reservoir McGregor's Hill	12,000
(6) Conduit 14 inch, 15,000 feet	34,000
(7) Distribution	50,000
(8) Services	3,000
(9) Engineering and legal	6,000
	$168,000

SCHEME (d).

Substituting an 8 inch main for the 10 inch would decrease the cost to $154,000.

The capacity of this 8 inch conduit would be about 400 gallons per minute, and at some time in the near future a second conduit would be required from the springs to McGregor's Hill.

SCHEME (e).

Pumping from Lake Ontario, capacity of each pumping engine 750 gallons per minute.

(1) Land and right of way	$ 2,000
(2) Intake pipe	6,000
(3) Pump-house, chimney and well	6,000
(4) Pumping machinery	11,000
(5) One filter	5,000
(6) Filter house	1,000
(7) Cottage	2,000
(8) Force main, 9,000 feet	17,000
(9) Standpipe	9,000
(10) Distribution system	50,000
(11) Services	3,000
(12) Engineering and legal	6,000
	$118,000

This system would probably require no enlargement or alteration in thirty years, except the addition of another filter or a sedimentation basin.

SCHEME (f).

Pumping from Oshawa Creek. Water power and steam power, 4th Concession.

(1) Land and right of way	$3,000
(2) Riparian claims	7,000
(3) Dam and accessories	10,000
(4) Wheel pits, building and chimney	6,000
(5) Water wheel and power pumps	4,000
(6) Steam pumping plant	5,000
(7) Mechanical filters	10,000
(8) Filter house	2,000
(9) Cottage	2,000
(10) Force main, 13,000 feet	23,000
(11) Standpipe	9,000
(12) Distribution	50,000
(13) Services	3,000
(14) Engineering and Legal	6,000
	$140,000

Another suggestion has been made, viz., to locate the pumping station on Oshawa Creek at the front of the 3rd Concession —at Ross' bridge—and pump entirely by steam. This would lessen the first cost, but operating expenses would be greater than in Scheme (f).

SCHEME (g).

Pumping Station Oshawa Creek, 3rd Concession, steam power only.

(1) Land and right of way	$ 3,000
(2) Riparian claims	7,000
(3) Dam and accessories	1,000
(4) Pump house and chimney	4,000
(5) Steam pumping plant	10,000
(6) Mechanical filters	10,000
(7) Filter house	2,000
(8) Cottage	2,000
(9) Force main 6,000 feet	11,000
(10) Standpipe	9,000
(11) Distribution	50,000
(12) Services	3,000
(13) Engineering and legal	6,000
	$118,000

The operating expenses in this system would probably be less than in the Lake System, owing to the elevation of the pump house, but if coal were used as fuel the cost would be greater than at the Lake shore.

The quality of the water is such, however, that I would prefer the Lake system.

It is quite true that by filtration very impure water may be made safe for drinking purposes. There are now several towns in Ontario that filter their water supply—Chatham and St. Thomas being the most important. I have examined many of the filtration plants in Canada, have constructed some and have inspected the Chatham and St. Thomas works several times. Knowing what I do of filtration systems and methods, and taking everything into consideration, I would prefer either the Lake or the Springs to Oshawa Creek water

after perfect filtration. The difference in cost between the Lake system and this system is less than would be supposed owing to the larger filtering plant required.

SUMMARY OF ESTIMATES.

SCHEME	(a)	Gravity direct—10 inch main	$160,000
"	(b)	" " — 8 inch main	147,000
"	(c)	" McGregor—10 x 14 inch main	168,000
"	(d)	" " — 8 x 14 inch main	154,000
"	(e)	Pumping from Lake Ontario	118,000
"	(f)	" " Oshawa Creek water and steam	140,000
"	(g)	" " " " (steam only)	118,000

The amount allowed for riparian claims is an extravagant sum in my in opinion.

It is possible that tile pipe may be substituted for the 10 inch iron for a short distance southward from the Thompson Springs. It is also possible that the conduit line may pass over some ravine and streams, or through hills, involving extra expenditure.

These matters can only be settled after a careful detailed survey has been made.

For a few years the reservoir and pumping station, on Trewin's Hill, may be omitted if the supply for fires becomes insufficient, the steam fire engine may be attached to the dydrants. When the domestic consumption increases to such an amount that a fire supply cannot be obtained by the steam fire engine, then a pumping station may be erected on or near Trewin's Hill, the supply to be drawn directly from the gravity main, and later on a storage reservoir built.

If the Town at any time installs a municipal electric system, the power house might be located with advantage, contiguous to the proposed pumping station—one boiler plant being sufficient for both systems. No extra labor would then be necessary for the pumping.

OPERATING EXPENSES.

With a gravity supply the maintenance charges will be less than in a pumping system, but the cost of pumping will equal the difference in fixed charges. The following is my estimate of the average annual charges for the next twenty years :—

	Gravity System.	Lake System.	Oshawa Creek.
First cost	$160,000	$118,000	$140,000
Interest at 4 per cent	6,400	4,720	5,600
Sinking fund at 1¼ per cent	2,000	1,475	1,750
Superintendent	500	500	500
Maintenance and Repairs	300	600	900
Fuel, Oil, &c.		2,400	1,000
Wages Engineer		600	600
Filtering		100	500
Average annual charges	9,200	10,395	10,850
Charges in 1904	9,000	8,500	9,000
Charges in 1934	9,000	12.500	12,500

I will here give for your information the operating expenses in some Ontario towns in confirmation of my estimate :—

Town.	Populat'n. 1900.	Cost Works.	Year Constructed.	System.
Barrie	6,000	$120,000	1891	Steam pumping to standpipe, low duty.
Berlin	9,750	130,000	1888	Ditto.
Brockville	8,900	200,000	1885	Steam pumping direct—high duty.
Cornwall	6,700	120,000	1886	Steam pumping to standpipe—low duty.
Galt	7,900	160,000	1891	Steam pumping to standpipe—high duty.
Orangeville	3,500	50,000	1895	Gravity.
Pembroke	4,500	60,000	1894	Steam pumping to standpipe—low duty.
Petrolea	4,500	187,000	1897	Steam pumping to standpipe—high duty.
Renfrew	3,200	65.000	1898	Steam pumping to standpipe—low duty—filtered.
Smith's Falls	5,200	100,000	1902	Steam and water power.
Walkerton	3,500	30,000	1891	Gravity.

Town.	Million gallons pump'd in year.	Pressure.	Year of return.	Operating expenses.
Barrie	52	80	1901	$2,500
Berlin	174	80	1901	3,600
Brockville	450	70	1901	9,300
Cornwall	180	70	1898	3,500
Galt	160	100	1901	4,500
Orangeville		50	1898	600
Pembroke	40	85	1899	1,200
Petrolea	146	100	1901	4,500
Renfrew	73	90	1901	2,200
Smith's Falls	190	70	1902	2,750
Walkerton			1897	700

At Pembroke, the exceptionally low operating expenses, are due to the fact that saw-mill refuse is largely used for fuel, at the cost of cartage.

REVENUE.

I estimate that the revenue to be derived from your Waterworks System will be as follows :—

Year.	Pop'n town	No. Services	Ordinary Consumers	Large Consumers	Hydts.	Total
1904	4,500	100	$1,200	$300	$5,000	$ 6,500
1909	4,700	600	6,000	300	5,200	11,500
1914	5,000	800	7,000	500	5,500	13,000
1919	5,300	1,000	8,000	500	5,500	14,000

The foregoing estimates of revenue are made upon the assumption that pure water is supplied to the citizens from the springs.

If filtered water from Oshawa Creek were delivered, the revenue would be very much less. Lake water, whether filtered or unfiltered, would not, in my opinion, be as popular as the spring water There would be a sentimental objection to drinking water into which sewage was discharged, even at a remote point.

The Waterworks revenues received by the foregoing towns were as follows :—

Town.	Pop'n	Year of return	No. Services	—Revenue— Ordinary Consumers	All Sources
Barrie	6,000	1901	650	$ 9,000	$12,000
Berlin	9,750	1901	1150	14,000	20,000
Brockville	8,900	1901	1560	18,000	24,000
Cornwall	6,700	1898	520	6,575	8,200
Galt	7,900	1901	1,500	8,000	9,000*
Orangeville	3,500	1897	200	1,300	
Pembroke	4,500	1899	565	5,000	*
Petrolea	4,500	1901	1,140	10,000	16,600
Renfrew	3,200	1902	350	3,400	6,200
Smith's Falls	5,200	1902	330	3,600	4,800
Walkerton	3,500	1897	300	1,500	

(*Nothing allowed for fire protection).

In five years the revenue from consumers at Pembroke amounted to $5,000 per year. Oshawa should do better than Pembroke.

In the small town of Renfrew, the revenue from consumers is now one dollar per capita of the population per year. Your revenue would certainly be no less than 5,000 in five years from domestic consumers only.

An examination of the returns from places where the works have been in operation ten years and over, will show a wide difference.

In Brockville the rates are high and extensions are made partially out of revenue.

In Galt the rates are too low.

Petrolea is an exceptional town, as the wells were generally unfit for use.

Berlin is an average town.

I have selected the returns re revenue and operating expenses with the view of showing what may be expected in your Town.

SCHEME RECOMMENDED.

In my opinion, you should adopt a gravity system, the water to be taken from Thompson's Springs or vicinity, the conduit pipe to be 10 inches in diameter from the source of supply, to the ground storage reservoir on Trewin's Hill for fire supply, fire service to be given by a high pressure fire pump, supplied with steam from two quick firing boilers. The pressure from the conduit will be sufficient to cope with small fires.

The objections to this scheme are the first cost, and the undetermined claims of riparian owners.

It can make no difference to the ratepayers whether the revenue received from Waterworks be expended in interest or in operating expenses, provided they obtain the same service.

I am of the opinion that in a very few years the gravity scheme will prove cheaper than the pumping scheme.

In comparing Oshawa with other places, the heavy pressure and the distance of the pump house from the harbor, must be considered.

If my estimates of operating expenses and revenue be correct, and I believe they are, your Waterworks system will be paying its way in five years.

The first cost appears large, but it is less than the amount expended by Petrolea for a pumping system, where the water is forced twelve miles overland from Lake Huron.

If the Petrolea works were to be constructed now, they would cost over $200,000.

The Galt works, another pumping system, if constructed to-day, would cost nearly $200,000.

Instead of erecting a pumping station at Trewin's Hill, fire service may be given by the steam fire engine by attaching a proper suction hose to a hydrant convenient to the fire. This is the method adopted for extinguishing fires in nearly all of the large cities of the world.

FIELD WORK.

Before tenders can be called for, careful detailed surveys and levels must be taken from Oshawa to the Thompson's Springs, and the conduit properly located as to alignment and grade. This work should be done as carefully as sewer work.

I failed to find among your plans and documents proper working profiles for the proposed conduits from either springs.

Respectfully submitted,

WILLIS CHIPMAN,

Civil and Sanitary Engineer.

TOWN OF OSHAWA,

PROVINCE OF ONTARIO.

REPORT UPON SEWERAGE,

By WILLIS CHIPMAN, C. E.

Toronto, November 22nd, 1902.

To the Mayor and Council of the Town of Oshawa, Ont.

Gentlemen,—The problem of disposing of your water supply, after it has been used for household and manufacturing purposes, and conveying it to the point of disposal, involves the construction of a Sewerage System.

TOPOGRAPHY.

That part of the town lying north of Bond Street falls rapidly towards the south, and practically every street in this portion of the town can be drained to King Street.

If a straight line be drawn from the Grand Trunk Railway Station to the Public School on Centre Street, thence northerly to the Roman Catholic Church, it will be found that all of the town west of this line now drains towards Oshawa Creek, and all east of this line to a small stream known as Ritson's Creek.

This eastern area is much larger than the western and the elevations are such that all of the town, excepting that portion west of Church street and Centre street as far south as Gibbs street, can be drained easterly. Centre street, south of Gibbs street, must be drained southerly, also Mill street, and probably some portions of other cross streets between Quebec street and the G. T. Railway.

Oshawa Creek is from 20 to 30 feet below Centre street and Church street, while the natural slope of the ground to the Eastern Creek is only about one foot in 300 feet.

To convey sewage from the vicinity of the Albert street school westerly to Oshawa Creek would require a cut of about 25 feet in depth at Centre street, at which depth rock would probably be met with. This sewer would be the only deep one required, and as the deep portion would be short, the extra cost would not be such as to prohibit its construction, if it were decided to carry the main sewer in that direction.

The excavating will be easy, little or no rock, or quicksand, and only for the necessity of constructing the outfall sewer and the disposal works, the sewerage problem would be a very simple and inexpensive one.

SYSTEM.

Until within recent years, it was the practice to discharge sewage proper and street water into the same sewers. Small open water courses were often utilized as sewage outlets until they became a nuisance, necessitating the construction of large and expensive sewers. This system known as the combined system, is the one to be found in all our older cities, but is open to many sanitary objections.

When the domestic sewage proper is discharged into one set of sewers, called sanitary sewers, and the street water into another, called storm sewers, the system is known as the separate system. At first it would appear that this duplicate set of sewers would increase the cost of the system, but as a rule, such is not the case.

As street water will not create a nuisance if carried in box drains, open ditches. or natural water courses, it is often possible to dispose of it in this way without constructing expensive undergroundsewers.

As Oshawa is located some distance from the lake, it would be expensive to convey the sewage there from the town, and I understand that it has practically been decided to discharge the sewage, after partial purification, into a small stream that flows southerly, east of the town, emptying into the harbor at or near the same point as Oshawa Creek.

If the sewage were carried south-westward instead of south-eastward, purification works would also be necessary.

When it is necessary to treat sewage it is essential that the separate system of sewerage be adopted, all storm water being strictly excluded from the sewers carrying household sewage, the rain water and street water to be carried in separate sewers.

Cellars may be drained into the sanitary sewers, but roof water should be discharged into the storm sewers.

There can be no question as to the advisability of adopting the separate system in Oshawa.

SANITARY SEWERS.

A tile pipe 12 inches in diameter will be ample for the sewage proper from 6,000 people, and a pipe 15 inches in diameter will serve 9,000 people, when laid with a minimum grade.

If the sewage be discharged towards the south east, the main sewer will be about 4,500 feet in length. If the purification works be located on the west side of the mill pond, the length of main sewer will be about the same.

Tributary sanitary sewers will eventually be required upon every street provided with a water main.

The surface elevations in your town are such that a good fall can be obtained on nearly every street. These sewers will be of moderate depth, and the excavations will be entirely in earth, with little quicksand or water to contend with.

Along the sanitary sewers should be built manholes and automatic flushtanks.

QUANTITY.

The quantity of sewage may be taken as equal to your water supply. The water wasted by leakage and otherwise, and used on lawns, street sprinkling, etc., may not all reach the sewers, but large quantities of ground water and some surface water will find entrance to the sewers, a sufficient quantity to offset the losses mentioned.

STORM SEWERS.

The disposal of street water is an important matter in our Canadian towns. Some provision must be made for it, otherwise streets and cellars become flooded with every heavy rain or winter thaw.

The storm water from Simcoe St. and all the town west of it, can be discharged through small separate sewers into Oshawa Creek. Practically all of the town north of King St. can also be drained westerly to Oshawa Creek.

The storm water from Celina Street, Albert Street, Prospect Street and Charles Street must, however, be carried to the eastward.

Proper catchbasins should be built along the storm sewers, also manholes for inspection and cleaning purposes.

The separation of the storm water from the sewage involves the laying of two distinct pipes or sewers, but it does not follow that the cost of construction is increased.

The quantity of domestic sewage is so small from any selected area of the town, compared with the storm water flood, that in designing a sewer system the sewage flow is generally omitted from the calculation. The sanitary pipe is comparatively small, but will be required on every street. The storm will be required on Simcoe Street, on King Street, and on a few other streets, but not on all.

If the sewage and the street water were carried together, a main sewer of sufficient size for the rainfall would be necessary from the town to the sewage disposal works, whereas with a separate system, only a small part of the storm water will be required to be carried any distance.

To purify the storm water mixed with sewage would require too expensive a plant.

PRESENT DRAINS.

For a great many years the town has been constructing drains, chiefly of planking, for removing street water, and for cellar drainage. A main drain was constructed in 1890 from Albert street, near Emma street, southeasterly across farming lands owned by to a free outlet about 30 yards west of the traveled road between Township Lots 8 and 9. This main drain is rectangular in cross-section about 24 inches wide and 20 inches high, the top being covered with timber.

This main drain and the tributary drains in town become blocked occasionally, by caving in, or by accumulations of sand and mud. Some household sewage now surreptitiously finds its way into the old drains, aggravating the danger from a general collapse of the old system which may occur at any time. These drains are not provided with manholes or proper catchbasins, and must sooner or later be abandoned.

SEWAGE DISPOSAL.

Whether the household sewage be carried southeastward, or southwestward, it will be necessary to partially purify it at least before discharging it into a watercourse or into Oshawa Creek. To accomplish this, the cheapest and best method will be to pass the sewage through a Septic tank that will contain about one day's flow of sewage.

This tank will remove about 50 per cent of the solids in suspension and 30 per cent of the solids in solution. The tank effluent will be dark in color and will have a decided odor. Complete purification may be effected by turning the effluent upon suitable land of sufficient area, by passing it through "bacteria beds," or by dilution in water. In your case the latter course may be adopted, but possibly in the future beds or land treatment may be added, or a pipe line laid to the lake.

It may be necessary to secure a right of way for the outfall sewers, and a few acres for the disposal works. The town should also control the existing stream from the disposal works to its outlet in the harbor.

Regarding the disposal of your sewage you have advantage over Guelph, Berlin, Waterloo, Brantford and many other inland places. At Sault St. Marie, Smith's Falls, Gananoque and several other places, the rock excavation has greatly increased the cost of water works and sewers. In Oshawa practically no rock will be met with.

EXTENT.

The construction of a sewer system must follow the construction of water works and the sooner the better, otherwise the full benefit cannot be derived from the water works. The additional revenue to be derived is worth considering.

In my opinion you should include a sufficient sum in your Waterworks By-law to construct such sewers as may now be required, or that may be demanded within the next five years, that is, the main trunk outfall sewers and the sewers on King and parts of Simcoe and some other streets should be built at the same time that the water mains are being laid.

The proposed eastern outfall sewer has a length of about 4,500 feet. For the present the existing drain can be used for storm water, a new pipe being laid for the sewage. Part of the old drain may require relaying with tile or be repaired.

Although 30,000 lineal feet of sanitary sewers will not completely sewer the town, this amount may not be required for several years, if built as local improvements. The storm sewers should be built at the same time as the sanitary sewers,as they can then be laid in the same trenches, and one set of manholes will do for both sewers.

ESTIMATE.

In the following estimates the cost of the manholes, flush tanks, catchbasins, and all other accessories are included, also the engineering, superintendence and sundry expenses, except the cost of land.

(a) Disposal works, septic tank only.....	$5,000
(b) Outfall sanitary sewer 4,500 ft. of 12 inch pipe	7,000
(c) Rebuilding or renewing outfall storm sewer..	1,000 to $3,000
(d) Sanitary sewerage in town 15,000 lineal feet..	25,000
(e) Storm sewers in town 9,000 lineal feet.....	5,000 to 10,000
	$43,000 to $50,000

About 12,000 feet of storm sewers will be required by the time the 30,000 feet of sanitary sewers are completed. I am informed that many of the existing drains can be utilized for storm water, in which case this item may be reduced.

Of this amount about $20,000 may be assessed upon abutting property owners, leaving from $23,000 to $30,000 as the town's share. It practically means that the town pays for the disposal works, the outfall sewers, the storm sewers, all exempt property and the street intersections, the balance being borne by the frontagers.

If you omit the Septic Tank for the present, the sum allowed for it in the estimate may be expended in extending the sanitary sewer system and in purchasing land and right of way.

If your Council decides that a more extensive system of sanitary and storm sewers should be built now, then my estimate should be proportionally increased, or approximately as follows :—

(a) Disposal works, Septic Tank only.....	$7,000
(b) Outfall sanitary sewer 4,500 ft. of 12 inch pipe.	7,000
(c) Outfall storm sewer.....	2,000 to $8,000
(d) Sanitary sewers in town 30,000 lineal feet.....	50,000
(e) Storm sewers in town 6,000 to 12,000 lineal feet.	7,000 to 13,000
	$73,000 to $85,000

The amount charged against the frontage would be about $40,000, the town's share being from $33,000 to $45,000.

In my opinion some amount between $25,000 and $45,000 should be raised as the town's share of the cost of the sewerage system, the balance to be raised by frontage tax.

PAYMENTS.

To raise by general taxation a sum sufficient to sewer part of the Town only would be an injustice to those portions of the Town not sewered.

To sewer the town piece-meal on the frontage plan, as provided by statute, would give you a disconnected, imperfect, unsanitary system of sewers.

I propose neither of these methods, but the uniform frontage rate system, the same as that adopted by Brantford, Barrie, Toronto Junction, Berlin, Niagara Falls, Smith's Falls, Sault St. Marie, and other places. By this method the Town Council by bylaw fixes the rate to be assessed upon abutting property,—this tax to be levied only where a sewer has been constructed. This frontage rate has, as a general rule, been sufficient to meet about half the total cost of the sewerage system, when such system is practically completed. The other portion of the cost is to be paid by the Town, the interest and sinking fund being met by a general sewerage tax.

The lower the frontage rate adopted, the higher the general tax, and the higher the frontage the less the Town's share.

For corner lots the Town may, by bylaw, prescribe some equitable exemption. This is generally fixed at about 100 feet for each corner, or half the total frontage, the exemption not to exceed 100 feet.

In case of a corner lot 33 feet by 131 feet, the assessed frontage would be 33 feet only, if a sewer were built on the front street and none on the side street. If a sewer were afterward, built on the side street, an additional 49 feet would be assessed, making 82 feet in all. If, however, the sewer were first laid on the side street, the assessment would be 82 feet, and no further assessment would be made.

If a building be erected at the rear of the lot, each building should be treated as a separate lot.

For Oshawa I would recommend a uniform frontage rate of $1 per lineal foot, an annual tax of about six cents per foot, to be collected only on streets when sewers are laid.

By The Local Improvement Act there are three methods of procedure specified for building a sewer :—

(1) By petition.

(2) By taking the initiative.

(3) As a sanitary measure.

In the majority of places the town proceeds on the initiative, until the principal sewers are constructed, and this is the method I would recommend you to adopt.

CONSTRUCTION.

By including with the Waterworks, pipe laying, that portion of the sewerage system now desired, closer prices can be obtained than if the work be let separately. There is also another advantage, your streets are only opened up for one season.

On some streets the water mains may be laid in the same trench as the sewers ; on other streets in separate trenches or on " benches" cut on one side of sewer trenches. This is a matter to be decided upon for each streat when the detailed plans are being prepared.

At Smith's Falls, Ont., at Edmonton, Alta., and at Newcastle, N.B., the municipalities are constructing Waterworks and Sewers concursently and many other places have done likewise.

CONCLUSION.

No town of the size of Oshawa can afford to be without Waterworks and Sewers, and you will find that after ten years the revenue from your Waterworks will be sufficient to meet all expenses in connection with Waterworks and Sewers. The construction of works aggregating a cost of nearly $200,000 may appear a large amount, but not unreasonably so when everything is taken into consideration, and I believe that a business proposition of this kind, that can be proven to be a paying investment in every other city or town, will appeal to the business men of Oshawa as a profitable undertaking.

Respectfully submitted,

WILLIS CHIPMAN,

Civil and Sanitary Engineer.

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REFERENCE

INDEX TO WATERWORKS REPORT.

	Page.
Location	4
Population	4
Quantity of Water required	5
Meters	6
Fire Supply	6
Quality of Water required	6
Historical	7
Source of Supply	8
Thompson's Springs	9
Harper's Springs	9
Lake Ontario	10
Oshawa Creek	10
Various Springs	11
Artesian Wells	11
Sources Compared	12
Analyses	12
Gravity Supply	13
Reservoirs	14
Size of Conduit	15
Riparian Claims	16
Lake System	17
Distribution System	18
Estimates of Cost	18
Summary of Estimates	21
Operating Expenses	21
Revenue	22
Scheme Recommended	23
Field Work	24

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3 9364 00722896 3

INDEX TO SEWERAGE REPORT.

	Page.
Topography	25
System	25
Sundry Services	26
Quantity	26
Storm Sewers	26
Present Drains	27
Sewerage Disposal	27
Extent	28
Estimate	28
Payments	29
Construction	29
Conclusion	30